JPRS-UMS-84-001

28 February 1984

USSR Report

MATERIALS SCIENCE AND METALLURGY

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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SUPERHARD MATERIALS

TITANIUM

WELDING

ALUMINUM AND ITS ALLOYS

UDC 620.178.7

MICROSTRUCTURE OF ALUMINUM ALLOY IN EARLY STAGES OF SPALLING

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 83 (manuscript received 5 Jul 82) pp 84-87

ROMANCHENKO, V. I., MARUSIY, O. I. and KRAMARENKO, I. V., Institute of Strength Problems, Ukrainian Academy of Sciences

[Abstract] Characteristic features of spalling fracture in response to a rapid pulsed load are described. The microstructure of type V95 aluminum alloy was studied in sections cut from the central portion of the disk-shaped target 15 mm thick subjected to flat impact by a plate of the same material at a speed of 155 to 270 m/s, leading to various stages of spalling. Cylindrical specimens were cut from impacted targets and tested on an Instron machine. Changes in residual strength at a tensile testing speed of 1 mm/min were recorded as a function of impact velocity. Photomicrographs of cracks and shear deformations at crack tips illustrate the successive stages in failure of the aluminum alloys upon high velocity impact. Spalling is found to be viscous in nature, with localized shear deformation in the stage of formation of major cracks an important process, its mechanism largely determined by the initial directed structure of the alloy. Figures 7; references 4: 2 Russian, 2 Western.
[24-6508]

UDC 669.71:539.376

FRACTURE OF ALUMINUM IN UNIAXIAL AND BIAXIAL EXTENSION AT 473-77°K

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 3, Sep 83 (manuscript received 23 Jun 82; in final form 6 Jan 83) pp 593-599

KUROV, I. Ye., DEMIKHOVSKAYA, N. N., SHAKHALOVA, G. I. and SHEVCHENKO, S. M., Gor'kiy Research Institute of Physics and Technology

[Abstract] A study is made of the temperature-time variation of strength of aluminum with simultaneous observation of the development of deformation and structural changes over a broad temperature interval with both uniaxial and biaxial extension in order to determine the mechanism controlling failure

under these conditions. Durability test data were used to calculate the activation energies of structure. X-ray diffraction studies and transmission electron microscopy were used to determine the dislocation structure of deformed specimens, and fractographic analysis of fracture zones was performed. Studies were performed on type A-7 99.7% aluminum foil 0.1 mm thick. For biaxial extension the deformation to rupture ε_k throughout the entire range of change of external conditions is constant, whereas under uniaxial extension at 77°K greater deformation is accumulated by the moment of fracture than at moderate temperatures. The results of fractographic analysis indicate that in all cases the fracture is viscous in nature. At moderate temperatures and uniaxial extension there is no local thinning of the foil, and the fracture surface is flat with numerous furrows almost parallel to the line of intersection of the fracture surface and the side surface of the specimen. In low temperature uniaxial loading there is significant local thinning, and the fracture itself has a cup-like structure with deep, narrow cups, indicating that large cracks were formed apparently by merging of individual microcavity cups. Mechanical testing and fractographic studies indicate that the mechanism controlling the process of deformation and fracture does not remain constant over the interval of conditions studied. Figures 4; references 20: all Russian. [23-6508]

UDC 669-494:451.124.16

FEATURES OF PHYSICOCHEMICAL REACTION IN ALUMINUM-BORON COMPOSITE MATERIAL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 14 Feb 83) pp 96-99

POSTNIKOV, V. S., LAVRENT'YEV, V. I. and SHORSHOROV, M. Kh., Voronezh, Moscow

[Abstract] Little study has been made of reactions in composite materials where an oxide film is preserved at the boundary between matrix and reinforcing material. The present study considers the promising combination of aluminum and boron fibers for reinforcement by a dynamic module of elasticity method and micro-X-ray spectral analysis. The proportion of fiber to matrix was determined optically. Results showed that increases in the dynamic module of elasticity were related to the increase in the high-modular intermetallic compound AlB_2, which was preceded by an incubation period for forming new phase muclei. While the method outlined has value, its drawbacks include measurement of only one side of the growth at the intermetallide's boundary. Rate of motion in laminate layers is also measured, showing that the tensions that develop are significantly less in an aluminum-boron system than in a titanium-boron counterpart. Figures 3; references 6: all Russian. [20-12131]

UDC 669.721'5787:669-494

REINFORCING MATERIALS BASED ON MAGNESIUM OXIDE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 12 Aug 80) pp 93-95

KARPINOS, D., GROSHEVA, V. M., MOROZOVA, V. N., DZEGANOVSKIY, V. P., MOROZOV, Yu. I. and YAKOVLEV, K. I., Kiev

[Abstract] Broad use of magnesium oxide ceramic material for construction is hampered by its brittleness and low heat resistance. The present study considers composite materials for reinforcing this ceramic using hot pressing, in which the liquid mass does not damage the reinforcing fibers. The matrix used consisted of magnesium oxide powder with particle size of 0.3 mkm, and

the fibers were made of tungsten and molybdenum. A maximum of 15% reinforcing material was established. The resulting product had slightly less flexibility than pure MgO ceramics, but impact strength grew in proportion to the content of fibers, with better results when molybdenum was used. Little reaction between fibers and matrix was noted. Thermal durability increased in proportion to the percentage of fibers added, up to the 15% maximum. References 4: 3 Russian (1 translation from English), 1 Western.
[20-12131]

ENERGY EFFECTS

UDC 533.9

EFFECT OF CONCENTRATED ENERGY STREAMS ON MATERIALS. PROBLEMS AND PROSPECTS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 27 May 83) pp 3-18

RYKALIN, N. N. and UGLOV, A. A., Moscow

[Abstract] Use of concentrated energy streams composed of electrons, ions, low-temperature plasma or laser beams, are finding numerous physical and physico-chemical applications. The present review covers processes of heat- and mass-transfer as well as certain applications. Heating and cooling of bodies, as outlined in mathematical models that consider thermophysical coefficients of substances, are described more precisely with non-linear than with linear calculations. Surface melting, especially with lasers, has promise for precision welding. Ablation and vaporization are described in thermal models. Hydrodynamics involved in fusion movement at surface layers and in melt baths are also presented. Autovibration of energy streams is important to determine thicknesses of layers in compositions. The nature and pressure of the surrounding environment provides another factor in controlling these processes, but instability remains a problem to be surmounted. Physical experiments are being used to perfect mathematical models. Applications include thermal processing and tempering, welding, cutting, various metallurgical procedures and numerous processes for porous materials. Computerized monitoring and production control are being advanced. Figures 7; references 72: 66 Russian, 6 Western.
[20-12131]

UDC 539.389.3

EFFECT OF ELECTRON IRRADIATION ON RELAXATION OF TENSION IN ALUMINUM AND ALUMINUM ALLOYS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 28 May 82) pp 89-92

BYSTROV, L. N. and REZNITSKIY, M. Ye., Moscow

[Abstract] Study of relaxation in metals and alloys during irradiation is an important issue in radiation research, since that process determines a material's

capability to maintain a given level of tension for design applications. Common studies based on internal friction during deformation do not provide sufficient accuracy. The authors considered cold-deformed and annealed pure metals and alloys on a device permitting deformation of a flat sample by torsion and maintenance of the deformed state throughout the test. Metals tested were pure aluminum and an aluminum alloy with 0.04% Mn, the latter being both cold-deformed and annealed at 300°C for 2 hours. Thermal and radiation-stimulated relaxation measurements were recorded. Results showed that the most rapid relaxation took place in the pure aluminum, followed by the cold-deformed alloy. The annealed alloy was more resistant. Relaxation was speeded in the first and last by irradiation, while in the cold-deformed alloy at low temperatures rapid relaxation occurred as in pure aluminum, and with high temperature (approaching 100°C), it was retarded. Figures 2; references 2: all Russian.
[20-12131]

UDC 539.23

SPECIFICS OF STRUCTURE FORMATION IN NITRIDES SYNTHESIZED BY LASER ACTION ON METALS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 272, No 5, Oct 83 (manuscript received 19 Apr 83) pp 1110-1114

RYKALIN, N. N., academician, UGLOV, A. A., GREBENNIKOV, V. A. and IGNAT'YEV, M. B., Institute of Metallurgy imeni A. I. Baykov, USSR Academy of Sciences, Moscow

[Abstract] For the first time a relationship has been experimentally established between auto-oscillating processes in a near-surface laser plasma and the formation of a nitride structure on the surface of the metal. The influence of radiation conditions and the method of feeding of nitrogen to the target on the structure and properties of nitride compounds synthesized on the surface of refractory metals is also determined. The radiation of a neodymium laser with a flux density of 10^5-10^7 W/cm^2, pulse length 1 ms, was focused on the surface of specimens of cast type VTI-0 titanium, with nitrogen fed to the surface from a jet nozzle coaxially with the laser beam at 1 to 80 m/s or with the specimen in a nitrogen chamber with a pressure of 1 to 100 atm. X-ray structural analysis revealed that in both cases a nitride was formed on the titanium surface, the nitrogen content of which depended on the processing conditions. Metallographic studies revealed differences in the structures of the experimental areas resulting from the parameters of the process. The kinetics of the phenomena occurring in the process are briefly discussed. In the nitrogen jet and in the nitrogen chamber at pressures of less than 10 atm the ionization of the laser flame is about 10^{-2}-10^{-3}%. The melt therefore contacts primarily molecular nitrogen. Increasing the pressure in the chamber over 10 atm increases the plasma temperature and its ionization, which reaches about 0.1%. This increases the solubility of nitrogen in the melt, helping to increase the depth of the nitride layer by decreasing the thickness of the solid solution. Oscillating processes cause a periodic change in the physical parameters and chemical activity of the plasma, leading to the formation of a multilayer nitride zone on the metal surface. Figures 1; references 6: all Russian.
[21-6508]

FERROUS METALLURGY DEPUTY DISCUSSES COKE SHORTAGES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Oct 83 p 2

[Article by A. Kogadeyev, acting minister of ferrous metallurgy, USSR]

The telephone message from the "Tulachermet" scientific industrial association to the ministry was brief: "For lack of coke we are compelled to shift the blast furnaces to slow operation. We ask that you fill our order for fuel!" If only this call were the only one! What can be said is that many of our plants frequently are short of coke--the main fuel for cast iron smelting.

What are the reasons? There are many, but three should be pointed out: a drop in the output of the most valuable coal grades, i.e., of coking coals, the impropoer utilization of this fuel by blast furnace workers, and its delivery for purposes which have nothing at all to do with cast iron smelting. Virtually every year each eighth ton of metallurgical coke is misdelivered.

More than once I have had the chance to see how diligently the representatives of many ministries and departments have asserted their rights in the Gosplan USSR in order to obtain coke for "technological or other needs." It should be admitted that for the time being they assert their rights fairly successfully although many kinds of more accessible fuel are available. After all, coke is attractive because it can be used easily, has a high caloric value, and can burn in any furnace. But its main purpose is to be used in metallurgical shops, in cast iron smelting.

There are great means for economizing on coke. One of them is to increase the hot blast temperature. By rapidly increasing the temperature significant amounts of fuel are being saved at the first, second and eighth blast furnaces at the Magnitogorsk Metallurgical Combine, the third and fourth blast furnaces at "Zaporozhstal'", the sixth blast furnace at "Azovstal'" and at Novolipetsk. Nevertheless, on the average, the hot blast temperature is being increased only very slowly in this branch of the industry, and in this matter the specialists of the ministry of ferrous metallurgy in the Ukraine (Minister D. Galkin), the "Soyuzmetallurgprom" All-Union Production Association of the metallurgical industry and "Soyuzspetsstal'" (chiefs A. Kugushin and L. Kosyrev) have much to do.

The same applies to the substitution of natural gas for coke, each cubic meter of natural gas being equivalent to 0.8 kilogram of fossil fuel. Good experience

has been gained in Cherepovetsk, Novolipetsk and Chelyabinsk, and at Yenakiyevo. However, in Orsko-Khalilovsk, "Krivorozhstal'", in the Dzerzhinskiy metallurgical works in Dneprovsk, Donetsk, in the Il'ich metallurgical works in Zhdanov and elsewhere the gas rate is one and a half time less, and too much coke is burned.

The metallurgists at the Karaganda Combine set an example in using mazut instead of coke. Good work for the future! However, on the branch scale it is still far from being the case.

This interferes with the solution of a main task of the eleventh Five-Year Plan--to lower the amount of coke for smelting one ton of cast iron by 33 kilograms (down to 500 kilograms). But great measures are being fulfilled: iron content in the ore is being increased, the hot blast temperature is rising, coal powder consumption in the blast furnace is being raised, the smelting of synthetic pig iron is more extensive, and blast furnace technology is being improved.

These are all urgent matters for metallurgists, as are the search for reserves for increasing coke production and raising its quality. Much remains to be done.

Putting new and refurbished coke ovens into operation ahead of schedule and implementing coke production are tasks taken upon themselves by metallurgists, coke-chemists and construction workers of Chelyabinsk oblast who have challenged co-workers in cooperating enterprises to competition. They encouraged by workers in the Altay area, in the Donetsk Basin, in the industrial areas along the Dnepr. As work is being carried out ahead of schedule in putting into operation and mastering the production of coke ovens at Chelyabinsk, Donetsk, Altaysk, and Zaporozh'ye it has become possible to produce hundreds of thousands of tons of fuel over and above the plan.

But this alone, however, cannot change the situation in the subbranch of the industry. It is necessary that all coke chemical production units function properly without failure and stoppage and provide metallurgists with high-quality fuel. Many of these units have become obsolete and should be revamped or substantially replaced. Machine-builders, however, are placing our orders only with difficulty and the only specialized plant for heavy machinery, "Slavtyazhmash", is overloaded. Also, the weak points of the repair base affect the entire situation.

Most of these problems are our own, i.e., are the problems of this branch of the industry, and we are supposed to solve them ourselves. More difficult is it with raw materials, which are needed both in sufficient volumes and in required quality by the coke chemists. Although the coal mining workers have improved their work, they have not reached a level to meet all requirements, to provide the coke chemical enterprises with the needed technological reserves. It happens not infrequently that there are only two or three sorts of coal instead of the four required in accordance with the technological process. For this reason new charge calculations frequently have to be done, and the coke ovens fail from time to time.

However, it is possible to help in solving the problems if Gosnab USSR would be willing to transfer funds for lean coals from the coke chemists to the power workers and to give the gas coals from the Kusnetsk Basin to the coke chemists. In caloric value they are equal; the gas coals, however, cake much better. It would also be more beneficial for the metallurgists if Gosplan USSR would carry out their decisions more efficiently. To substitute for coke in lime roasting shaft furnaces Gosplan allocated anthracite and graded lean coals for the current year. What do we really obtain? Not graded lean coals, which are not suitable for the purpose.

Well, we are compelled to waste coke which is desperately needed by blast furnace workers for lime roasting. Others are not forced, but they just waste it--for fertilizer and sugar production, for slag cotton and glass manufacturing, for dolomite and lime roasting, for smelting pig iron and other metals. Each year, ten thousand tons of coke are used for drying rooms after their construction by the chief housing construction department in Moscow and Leningrad as well as in the chief industrial construction department in Moscow. This same amount of fuel used in the famous ninth blast furnace in Krivoy Rog could melt 20,000 tons of high quality cast iron.

Enterprises of about a hundred ministries and departments "dislodge" funds for coke only with difficulty and give them up begrudgingly. In the "Azot" ["Nitrogen"] association in Kemerovo the switching of ammonia and other product production to gas was delayed for a whole year. Only after lengthy debate were the furnaces of the glass melting furnaces in Novosibirsk gasified. Only to a limited extent have cupola furnaces been substituted for shaft furnaces in the All-Union Ministry of Special Construction and All-Union Ministry of Construction Material Production.

Each year a large amount of metallurgical coke is consumed by the enterprises of the Ministry of Nonferrous Metals of the USSR. Our eolleagues are for reduction of funds for this fuel. They will talk willingly about new technical equipment and technology which will make it possible to lower considerably the coke consumption at the Irtyshsk Polymetallic and Ust'-Kanenogorsk lead-zinc combine, and to give it up completely at the Far East polymetal production association. But what do we have in fact? The "economical" units are being introduced slowly in Kazakhstan, and in the Far East polymetal association, construction of such units has not even begun.

The State Committee on Science and Technology, which as far back as last year promised to approve the agreed upon program for research and putting into production of coke briquettes made from weakly caking coals, must bear a considerable part of the blame. This program, in particular, provided for cessation, in 1990, of the use of coke for production of pig iron in cupola furnaces and for the melting of mineral raw materials in the shaft furnaces of the Ministry of Nonferrous Metals of the USSR.

Another problem is the reduction of consumption quotas for foundry coke in cupola furnaces. Reluctantly occupied with this work are enterprises of some of the machine building ministries, primarily of the Ministry of the Automotive Industry and the Ministry of Heavy Machinery. There the personnel complain habitually of low coke quality but do not concern themselves with other kinds of fuel at all.

I am reminded that the lean coals of the Kuznetsk Basin are suitable replacements for coke and that these coals should be delivered in large volumes by the "Raspadskaya" central concentration plant in Mezhdurechensk. Startup of this plant is scheduled for next year, but it won't occur by that time. Because of the lengthy construction period the plant project became obsolete and had to be revised a year ago. Now the earliest the plant could be in production is 1987. How to decrease coke consumption for non-blast furnace needs under such conditions!

The production and consumption of coke is an interdepartmental problem. Practical experience shows that the efforts of metallurgists alone are evidently insufficient to solve it. To increase coke production and to enhance its quality is to stop half-way. It is necessary to consume it rationally and to substitute other kinds of fuel for it where possible. It goes without saying that funds for it should not be allocated at current levels.

12563
CSO: 1842/16

COKE OVEN CONSTRUCTION LAGGING IN SOME AREAS

Moscow STROITEL'NAYA GAZETA in Russian 13 Nov 83 p 2

[Article: "Bread of Metallurgy"]

[Text] Economic Review

Coke can rightly be called the bread of ferrous metallurgy. Without it, you will not get a single ton of iron. The urgent need to provide coke to many of the sector's enterprises has propelled coke batteries under construction and reconstruction into projects of primary state importance. In recent years the volume of their construction has increased considerably.

Today coke batteries should be built and rebuilt at the Magnitogorsk and Kuznetsk metallurgical combines, the Chelyabinsk Metallurgical Plant, and the Altay, Zaporozh'ye and Kommunarsk coking by-product plants.

Less than two months remain of this year. How is the fulfillment of this important economic task going?

Example of the Initiators

At the beginning of this year, the collective of the Order of Lenin and Order of the October Revolution Magnitostroy Trust introduced an initiative to stimulate a builders' competition for early fulfillment of the plan to put coke batteries into operation. Its obligations were published in "Pravda." The Magnitogorsk workers pledged, based on full-scale introduction of the brigade order and concentration of efforts and material and technical resources at start-up sites, to put into operation two months before the deadline the powerful No. "7-bis" coke battery at the Magnitorgorsk Metallurgical Combine.

The initiators kept their word. This coke battery was started up in September, three months before the plan deadline. Metallurgists received tens of thousands of above-plan tons of products which they greatly needed.

The Magnitogorsk workers have become very experienced in the construction of these projects. Their experience may become a real school for the construction of domestic coke batteries. Their buildings are distinguished by a high level of engineering preparation, labor organization, and strict observance of technological and executive discipline by all participants in the construction.

Councils of the secretaries of party organizations play an important role here in motivating the collectives to fulfill their tasks successfully. Working actively are party groups and party organizers at construction sites and in brigades. "Ten-Day Periods of Labor Achievements" and "Months of Highest Labor Productivity" are being introduced at the initiative of the communists. There is widespread competition in honor of the celebrated original builders of Magnitka. Brigades, sections, and administrations compete in the construction of the "7-bis" battery by the day and in 10-day periods. The names of the winners are engraved on the sides of a special prize, which is on permanent display at the Museum of Labor Glory of the Magnitogorsk workers.

Such was the case in the construction of the powerful "*-bis" Magnitogorsk battery, which went into operation in 1981. It was built in 23 months, instead of the planned 26 months. The new "7-bis" battery, which went into operation this year, was built in still less time--21 months.

Reconstruction of the coke battery at the Chelyabinsk Metallurgical Plant is ahead of schedule.

These buildings are the center of attention of the oblast party organization. At the meeting of the party's obkom bureau, members regularly examine the progress of work on them and adopt specific measures to increase the party's influence on the unconditional fulfillment of plans and obligations. The Glavyuzhuralstroy [Main Administration for Construction in the Southern Ural Economic Region] (headed by Comrade Safronov) provides the construction project with the necessary labor and material-technical resources and singlemindedly manages them.

As provided for by the builders' commitment, work to transfer coke battery No. 5 was completed early, in September, at the Kommunarsk Coking By-Product Plant.

A high level of discipline, coordination of the actions of all construction participants, and the widespread comprehensive competition of sub-contractors according to the "Workers' Relay Race" principle will assure the success of the leading collectives.

Why the Setback

Unfortunately, this situation is far from being the case everywhere. At a number of coke batteries, both those in the initial stages and those already built, work is lagging far behind planned quotas and schedules. Moreover, the introduction of some of them into a planned deadline threatened disruption. Here are the specific facts.

At the building site of the second stage of battery No. 2 of the Zaporozh'ye Coking By-Product Plant, construction and assembly work for almost 2.5 million rubles was not completed over the surveyed period. The construction of chemistry and machine hall projects especially fell behind schedule. The builders are not solely to blame for this. The customer, i.e., the plant management, delayed freeing the area which had been allocated for construction of the battery's projects.

A tense situation developed at the construction site of a complex for thermal charge preparation for the No. 7 coke battery of the Western Siberian Metallurgical Combine. This is the first installation in the country to be built according to the new technological plan. Its startup will make it possible to increase coke output by almost a third, compared to that obtained at ordinary batteries. However, through neglect of this project by the directors of the USSR Glavkuzbasstroy Mintyazhstroy and of the organizations of the USSR Minmontazhspetsstroy [Ministry of Installation and Special Construction Operations], construction of the experimental installation was delayed for many years. The situation is no better today. After three quarters of a year only 43 percent of the plan for construction and installation operations had been completed. The installation of metal structures is especially lagging behind; this in turn delays assignment of the operations front to mechanical installers. However, neither the directors of the Sibstalkonstruktsiya Trust nor of the USSR Minmontazhspetsstroy have yet taken concrete measures to correct the situation.

Organizations of the USSR Minstroy [Ministry of Construction] must complete almost 5 million rubles' worth of work before the end of the year at coke battery No. 3 of the Altay Coking By-Product Plant. The disruption in deliveries of a number of items of technological and electrotechnical equipment is delaying builders and installers. So far the coke pushers have not been completely fitted out, and there are not enough electric motors, belt conveyors, start-control fittings, special tubes, etc. Deadlines for their deliveries expired a long time ago. The builders of this battery have heard more than once the promises of the deputy ministers of ferrous metallurgy, Comrade Pryanishnikov, of chemical and petroleum machine engineering, Comrade Rutskov, and of heavy and transport machine engineering, Comrade Zvizhulev, but, as we see, they have not lived up to their word.

Battery No 5 of the Kuznetsk Metallurgical Combine is being transferred at an extremely slow place. The builders, installers and startup personnel here clearly do not have enough time to complete their work this year.

Both Startup and Surplus

Speaking of startup, builders of coke batteries should devote considerable attention to the creation of a necessary stockpile for 1984-1985. For this, construction and installation operations for 30 million rubles must currently be completed on the stockpile projects. Frankly, the situation at these sites is far from favorable. Only 70 percent of the allocated means has been assimilated here after three quarters of a year.

The construction of coke batteries at the Karaganda and Kuznets metallurgical combines, and the Bagleyskiy and Kommunarsk coking by-product plants is developing slowly. A powerful battery at the Nizhne-Tagil Metallurgical Combine, at which the contractor, Glavsreduralstroy after 10 months has underfulfilled work by 1.5 million rubles, is being built at a slow pace.

The disruption in deliveries of refractory materials by enterprises of the USSR Minchermet [Ministry of Ferrous Metallurgy] is a great hindrance to the construction of these projects. It is very likely that not one of these coke batteries under construction has received refractory articles on time.

Directors of contracting ministries and of USSR Minchermet should thoroughly analyze the situation at each start-up and stockpile site, and take urgent, effective steps to overcome the supposed delay.

It is a matter of the honor of builders, installers, metallurgists and all construction participants to implement all planned capacities for coke production and completely assimilate the means allocated for their construction and reconstruction opportunely and skillfully.

12421
CSO: 1842/27

PROBLEMS IN FERROUS METALLURGY INDUSTRY EXAMINED

Moscow PRAVDA in Russian 24 Oct 83 p 2

/Article by Vyacheslav Goncharov: "Metal: Rubles, Tons and Percentages: An Economic Review"/

/Text/ At one of the metallurgical plants I was witness to an argument among specialists about a very acute problem: what should be the criterion for paying bonuses? Some vehemently believed that there was no room for different opinions - the bonus should only be given for the appropriate final work results of the entire collective, meaning for fulfillment of the plan for sales volume taking into consideration the extent to which the socialist pledges were met for deliveries in accordance with the contracts that had been concluded. Others were equally certain that a bonus should be paid for improvement in the intermediate indicators.

The polemics themselves and the arguments clearly lay bare the imperfection of the material and economic incentive system in one of the key sectors of the Soviet national economy, which is still closely linked with the gross product indicators.

In the press much has been written about the fact that in pursuing the cost gross product indicator many economic managers have been forced toward wastefulness. The more expensive the product the better the work of the collective is evaluated, which meant that the size of the bonuses grew.

However, the metallurgical industry workers were not expected to pursue the gross product indicator; they were required to produce a specific assortment of products - rails, beams, sheet metal, rounds of metal, fittings and so forth. But this was true only at first glance. In actuality metals with solid additives of costly alloy elements were given a "green light". Preference was given to heavy profiles: they could be converted into rubles and tons more quickly.

Let's Count

Intersectorial cooperative deliveries of steel ingots provided a special addition to the gross product indicator. This was a real discovery! Totally unconnected with the narrow specialization of the enterprises, they quickly increased to incredible amounts. This year the plants will deliver to each other almost 15 million tons of various ingots in semifinished form, just short of three million tons of steel bars and more than five million tons of pig iron.

You would be amazed at the number of railroad cars that it takes to transport this material! A great deal of excellent timber and boards is used to reinforce and secure the bars and blanks in the railcars during their transport. For the national economy such cargoes are weights on legs. But it is an advantage for the metallurgy industry. The explanation is simple: the more semimanufactured goods that a plant sells - such as pig iron and steel bars, and for the output of a finished product the ingot is brought in from somewhere else - the better the result of the plant's economic activity. And who will undertake to explain why powerful rolling mills are almost always built in places where there is no surplus of steel for their own purposes. Is it not the pursuit of cost indicators that is the true reason for the imbalances in the development of some enterprises?

The great mathematician Leibnitz has said, "there is no need to argue, let us count." Due to this "purchase-sale" system, the Cherepovetskiy Metallurgical Combine has raised the average annual worker output to 55,000 rubles without any problems; this is significantly higher than for the sector overall. But they built an oxygen coverter shop here, and a major portion of the pig iron that was sold just yesterday to someone else has been sent to the process stage here. Increasing the smelting of one's own steel has made it possible to reduce the need to bring in slabs from somewhere else. It would seem that this is an excellent arrangement. But the Cherepovets metal workers have fallen into a difficult situation. The per-worker output in rubles has fallen. And labor productivity is a fund-forming indicator, as everyone knows.

Here is another example. The Volgograd Krasnyy Oktyabr Plant ships some 200,000 tons of steel bars on a cooperative basis each year: the old blooming mill was unable to process all of the metal that is smelted. At the same time nearly 350,000 tons of ingots are brought in from elsewhere for the rolled metal shops. Last year they modernized the assembly and expanded the furnace equipment. This made it possible to increase the processing stage of their own steel by 40,000 tons, while decreasing the amount of steel that it brought in from elsewhere. The advantage to the state is clear. And the plant economists came to grips with the facts: putting the production facility in order resulted in a reduction in the annual sales volume of seven million rubles.

In the future the Volgograd workers will have every opportunity to reduce the amount of steel that it ships and to put it to work in place. But this will unavoidably reduce the gross product indicator by another 43 million rubles. And if one evaluates the work of the collective according to the old ways, the indicators will really get out of hand. In this instance what is to be motivated?

However, the pursuit for the gross product indicator is happily coming to an end. At one of the intersectorial meetings of the managers of the economic services the chief of the USSR Ministry of Ferrous Metallurgy's Planning and Economic Administration, I. Vashchenko, reported that the ministry is now switching to a new indicator - the standard net product indicator (NChP) - which more accurately reflects labor outlays.

Last year the work of the metal wares enterprises was evaluated by the NChP. The new indicator created the economic prerequisites for the mutually advantageous output of any metal product. This year the pipe and ferroalloy plants and the Vtorchermet /State Trust for the Procurement and Processing of Secondary Ferrous Metals/ enterprises were switched to the NChP. Starting in 1984 labor productivity and the salary fund for the sector on the whole will be estimated in the new manner.

The Broken Telephone

Why should there be this desire to obtain ingots from somewhere else and to chase after railroad cars to no avail? The explanation is simple. For a long time industry was faced with the tasks for a rapid quantitative increase. They were prompted by life. And if you recall we perceived the smelting of the one hundred millionth ton of steel as something to celebrate, as was our elevation to being the leading producer of steel in the world. And these truly were something to celebrate. The pace of the effort determined everything. But they gave birth to the indisputable authority of the gross product indicator, which to please some even came to despise the interests of the state. And here we are speaking not only about rubles but about tons.

The measures that were taken by the party and government to improve the economic mechanism have directed the labor collectives toward first of all fulfilling all contractual obligations for product deliveries, improving its quality, and increasing the economic effectiveness of production. And this is already bearing fruit. However, the old habits still make themselves known.

Recently at a meeting of the collegium of the USSR Ministry of Ferrous Metallurgy the work results of the sector for the first nine months of the year were totalled. Metallurgical plant managers gave speeches. How a year and ten years ago, they operated with figures for the total tonnage: how many tons were smelted and what was the shortfall in rolled metal. The question about

the fate of contracted deliveries in the best instance was touched upon only at the end of the speeches. And then only in response to tough questions from the minister. There is nothing to be surprised about in this. As before the work of the metallurgy workers is being evaluated in terms of the gross output in tons. The more steel that a plant produces the better. As to the quality of the rolled metal that is coming off the rolling mill stands - that is another matter of secondary importance. The figures confirm the accuracy of this point of view. Here is data from the USSR State Committee for Material and Technical Supply for the first six months of the year. The production plan for finished rolled metal by the USSR Ministry of Ferrous Metallurgy has been exceeded by 200,000 tons. At the same time out of 48 basic varieties of products the national economy has received only four. There is a shortage of the remaining 44 basic types.

Among those that are "difficult" to fulfill is the assignment for the production of sheet metal. The Cherepovetsk Metallurgical Combine alone fell short in its production of sheet metal by many thousands of tons. What is the reason for this? The combine director, Yu. Lipukhin, explains that this is the result of technical and organizational disorders. However, the very same rolling mill has been used to produce quite a bit of metal plate in excess of the plan. Finally the director admitted: "for ... three weeks in August the rolling mill was idled due to a lack of metal for 40 hours. This leads one to ask what could be rolled during the remaining time? Pipe billet. It is thick, which means that it is heavy."

Once again, it turns out that they are in pursuit of gross output indicators. But it would seem that they have put an end to this. This year some 46 enterprises within the sector, which manufacture some 95 percent of finished rolled metal, received their plan in standard tons rather than in physical terms. This means that the labor intensiveness for the various profiles was taken into consideration. The material incentive system is also linked to the new indicator. Now any product is advantageous to the metallurgy workers. And intersectoral statistics demonstrate that the ice has been broken. There has been an increase in the output of labor intensive and economical types of rolled metal. So what is the problem now?

The explanation is simple. The plants are counting standard tons while the all-union industrial association and the headquarters for the sector are using real /metric/ tons. At different levels there are different evaluations! And naturally this means that there are different approaches to the business at hand. Everything resembles the childrens' game of broken telephone.

According to the Final Result

There is a need for a limited but flexible system of cost, natural and labor indicators which can direct the enterprises and the sector overall toward final results. He who does the best job of fulfilling the pledges that he has made and achieves the assigned target with the least outlays must receive the honor. And the bonuses and salary must simply be converted into a powerful lever for moving the sector forward and for raising the effectiveness of its production.

Meanwhile at the plants the material incentive systems are so complicated, so surrounded by parentheses, that a beginner needs months to figure them out. The whole thing has gotten out of hand. At one time specialists from the USSR Gosplan asked several enterprises from the ferrous metallurgical industry to describe the present statutes regarding the awarding of bonuses. And this is the reply that they received from the Nikopol Southern Pipe Plant. How, they asked, can we comply with your request? After all we have several hundreds of these systems. Is this not the reason that the bonuses are often losing their impact and becoming just another addition to salary?

The incentives for engineers have been weakened in their primary purpose. In the office of the deputy director of the Novolipetsk Metallurgical Combine I saw an entire placard with a long list of basic and additional conditions for awarding bonuses to management workers. There were 18 points! And each of them was in turn broken down into subpoints. As they say, there are too many examples.

The sectorial economic mechanism needs to be improved in concert with a precise guiding of all workers to a single goal - fully meeting the needs of the national economy for the product that is being manufactured in accordance with the contracts that have been concluded. This is true not only for the metallurgical workers, but for the USSR Gosplan, the organs of material-technical supply and transport workers as well.

Together with Partners

Solid unused reserves can be found through a correctly organized socialist competition. Meanwhile as of today many major enterprises with a full production cycle will be excluded from those who aspire to be prize winners. Why? A statute has gone into effect that states that the Red Challenge Banner and money awards cannot be given to plants and combines which have not fulfilled their contracts for everything by 100 percent.

This is all correct. But let us ponder this. One hundred percent- this is just the limit, the ideal of work, toward which each collective must strive. The 100 percent fulfillment of orders not only presupposes the 100 percent mobilization of internal reserves, but also a balanced material-technical support, the strict observation of schedules for construction and installation work for modernization and rebuilding, and also transport services. And do they all have similar conditions? For many enterprises they still do not exist. And this becomes quite clear.

Let us take a look at the work report for sector leaders for the first eight months of the year. The delivery plan was fulfilled by 99.3 percent by the Novolipetsk Combine. The West Siberian Plant fulfilled 99.2 percent, the Nizhniy Tagil Combine by 99 percent, the Cherepovetsk by 98.4 percent, and the Magnitogorsk plant by 98 percent. Why weren't the contracts fulfilled by 100 percent? What sort of "brakes" came into play - internal or external? Or is it their habit of chasing after tons. Today these questions wait to be answered. Many specialists have told me that to fulfill pledges by 100 percent on contracts it is necessary to overfulfill the production plan by one or two percent or to accordingly reduce the number of orders that are made. Who is right?

Probably it would be proper in evaluating the work of plants to take into consideration the breadth of assortment of the product that is manufactured. But it is also necessary to point out that one of the main conditions of work on orders is to raise the exactingness not only upon oneself but also upon the partners in the undertaking. And this is particularly true of the transport workers. They must precisely and quickly fulfill all orders for transporting product. And the construction workers also have a role to play. They are responsible for the timely completion of new sections and shops and for the modernization of equipment assemblies. In this regard the entire world must proceed toward the goal.

And one more thing I would like to say. We are accustomed to there being outstanding enterprises in each sector. We will not close our eyes to the facts: they become outstanding through the selfless labor of their collectives and the heightened attention toward them and specific help from the local and sometimes the central organs. It is thought that the time has come to put our entire sector, the ferrous metallurgical industry, on this outstanding level. Today a great deal is being done to improve the work of each plant. The metallurgical workers have begun to fulfill the plan. But they still have quite a few problems, which must be solved through common efforts.

8927
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INFLUENCE OF AGING IN MARTENSITE STATE ON MECHANICAL PROPERTIES OF Cu-Al-Zn SYSTEM β-ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 83 (manuscript received 28 Jun 82) pp 81-83

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[Abstract] A study is made of the thermokinetic variation in mechanical properties of high damping β-alloy in the system Cu-Al-Zn in the process of aging at temperatures below the beginning of the reverse martensite transformation (A_n). An alloy with a composition of Cu+8.7 mass % Al+12.7 mass % Zn was produced in an induction furnace under cryolite, annealed at 500°C and quenched in water from 700°C, then aged at 300 and 400°C for 2 to 120 minutes. Mechanical properties were determined by the standard methods, including tensile testing and impact bend testing. Aging was found to have a multistage nature, leading to a nonmonotonic and complex change in mechanical properties. By varying the aging conditions in the martensite temperature area it is possible to significantly increase the strength of hardened single phase β-alloys without decreasing ductility. Figures 3; references 8: 6 Russian, 2 Western.
[24-6508]

PROGRAM FOR PROCESSING RAW MATERIALS

Moscow EKONOMICHESKAYA GAZETA in Russian No 38, Sep 83 p 2

[Article prepared by the Department of Metallurgy of the State Committee on Science and Technology: "The Comprehensive Use of Raw Materials"]

Mining branches annually deliver more than 15 billion tons of mineral raw materials, including more than 1.5 billion tons of ores headed for concentration, to the national economy. In connection with the constant trend of reducing the content of metals in ores and increasing the needs of the national economy, the mining capacity has been doubled every ten years.

In the current five-year plan, the development of progressive industrial processes and equipment for mining and concentrating ores of ferrous, nonferrous and precious metals, the increase in the completeness of recovering useful components and the complexity of using mineral raw materials are provided by the purposeful comprehensive scientific and technical program: "The Development of Equipment and Technology for the Mining and Concentration of Mineral Resources and the Introduction of Cyclic-Flow Technology of Mining Operations by the Open-Pit Method."

Mining More

Ore deposits of ferrous metals, as a rule, have large dimensions in area and comparatively low bedding depth. This circumstance makes it possible to mine such deposits by the open-pit method, using high-capacity drilling, mining-transport and loading equipment. An example of this can be the Kursk Magnetic Anomaly or KMA.

The mining of ores of ferrous metals by the open-pit method has increased from 71.2% in 1965 to 86% in 1982. Subsequently, a considerable change with respect to underground mining has not been proposed.

Assignments of the purposeful comprehensive program have provided the introduction at a number of the large mining and concentration combines of USSR Minchermet [Ministry of Ferrous Metallurgy] and USSR Mintsvetmet [Ministry of Nonferrous Metallurgy] of cyclic-flow production process for mining and transporting the mining substance and developing and organizing the production of equipment for this technology: mobile crushing units, heavy-duty conveyors and others. In transporting the ore, this allows replacing part of the route

of the truck or railroad transport by conveyor transport and thus lowering the need for rolling stock and ensuring a rhythmic (in quantity and quality) delivery of the ore to concentration plants.

It is envisaged to obtain a significant growth in the volume of the mining and concentration of sands of loose deposits from the introduction of transport-concentration complexes of high productivity with conveyor and hydraulic loading. This work is being fulfilled by organizations and plants of the USSR Mintyazhmash [Ministry of Heavy Machinery] and USSR Mintsvetmet.

The institute "Mekhanobr" [All-Union Scientific Research and Planning Institute for the Mechanical Processing of Minerals] and "Uralmash" [Ural Heavy Machinery Plant imeni Sergo Ordzhonikidze] developed a beveled-inertial crushing machine with the diameter of the bevel at 2.2 meters. This machine is capable of providing a 3-4 times greater degree of crushing, which makes it possible to replace the second and third stages of crushing by one stage at the concentration plants. Consequently, in designing plants which use heavy crushing mahines, the special feeders of loading assemblies and a considerable number of hoppers and conveyor transporters can be abandoned. This crushing machine uses 1.5-2-fold less pwer as compared with those now being used and does not require heavy foundations. The design allows stopping and starting without clearing the crushing chamber.

Manufacture of the machine in a special version opens up prospects of using it for crushing secondary raw materials of nonferrous and ferrous metals before their separation. Licenses for producing such equipment have been purchased in our country by firms of the USA and Japan.

Recovering More Completely

The raising of the extent of recovering the useful components, including metals, in the mining and concentration of ores is achieved by introducing special industrial processes, equipment, flotation reagents, sorbents, and extracting agents. For example, the including into the industrial production of slightly oxidized quartzites (the minerals hematite and martite), minable as by-products in enormous amounts (up to 50 million tons per year), depends, to a considerable extent, on the qualitative completion of development under experimental-industrial conditions of combined magnetic-flotation technology of the concentration of these ores with closed water recycling.

An alternative solution to this problem is envisaged by the program: the development of electromagnetic separators with a high magnetic field strength, up to 1.5 Teslas and higher.

The combined magnetic-flotation technology with closed water recycling, as compared with the strictly magnetic variant, has a whole number of advantages, the most important of which is the coarser primary crushing of the ore. This means a 20%-40% reduction in the capital outlay and operating expenditures.

Furthermore, in further industrial operations, the finely crushed material (down to 44 microns), to a considerable extent, yields in its "technological effectiveness" to the coarsely crushed material (down to 74 microns). It is

considerably more difficult to consolidate, filter and make into pellets, and the storage of the slime becomes a national economic problem: the construction of expensive poured dams is necessary, whereas with coarse crushing cheap earthen dams will suffice.

It bothers us that USSR Minchermet (chief of technical administration, V. Antipin, and director of the institute "Mekhanobrchermet" [All-Union Scientific Research Institute for the Mechanical Processing of Minerals of Ferrous Metallurgy], G. Suslikov) does not given proper attention to the development of the combined magnetic-flotation technology of the concentration of oxidized ferrous quartzites with closed water recycling. The continuity of the industrial process in conducting the experimental-industrial tests of this technology did not exceed three days. The conditions necessary for an objective evaluation were not created: isolation of the industrial scheme, stability in providing ore and water (including "recycling"), and reliability of operation of the equipment.

The fact that machine-building plants are not able in a short time to organize production and provide mining and concentration combines of USSR Minchermet with the necessary number of electromagnetic separators of the proper quality with high magnetic field strength is no less important. In fact, according to data of the "Mekhanobrchermet" institute, about 180 separators are needed for processing only 30 million tons of oxidized ferrous quartzites per year.

In addition, much time and resources are expended to develop electromagnetic separators with high magnetic field strength. Besides the need for fine crushing, magnetic separation of oxidized ferrous quartzites has another shortcoming: this technology is not capable of providing the necessary continuity of operation of the equipment. Enormous amounts of ore must be passed through the gap of matrices of electromagnetic separators (0.8-2 mm), and this requires solving the problem of the "classification" of mineral raw materials.

Another problem, which is just as important, in the field of the concentration of mineral raw materials of ferrous metallurgy is the reduction of losses in the processing of manganese ores. In some cases the hardness of manganese ores can be lower than that of oxidized ferrous quartzites by 2-3 fold. The main losses are due to the fine slime found either in the ore or appearing in the treatment process of the ore. In this case the electromagnetic separators with high magnetic field strength (the use of which for the concentration of oxidized ferrous quartzites is hardly promising) can be found "on site" and can provide a reduction in losses and an increase in quality of the manganese concentrate.

Tge development of so-called chemical methods is an important trend in the field of concentration of manganese ores called for by the scientific and technical program. Two important problems are being solved. First, a growth in reserves is provided because of the involvement in repeated industrial production of accumulated slime of oxidized manganese ores from the processing of previous years and the involvement in production of carbonate manganese ores, the proved reserves of which are great but almost were unused due to the absence of an efficient technology of their processing. Secondly, a high-quality concentrate is obtained, and phosphorus content of it is one order

lower than that at present. Thus the production of low-phosphorus high-quality steel for machines and equipment in the northern version is simplified.

The flotation process is the main process in the concentration of ores of nonferrous metals. Unfortunately, the dSSR Minkhimprom [Ministry of Chemical Industry] and USSR Minneftekhimprom [Ministry of Petroleum and Chemical Industry] do not pay proper attention to the problem of development of and provision with effective flotation agents of nonferrous metallurgy and other mining branches, as is defined by the program. For example, the development of industrial processes of the flotation of copper-molybdenum and lead-zinc ores using the so-called MIG-40 reagent is restrained due to its lack of supply in needed quantities by "Soyuzmetanol" [All-Union Office of Methanol] (D. Brazhnik, chief) of Minkhimprom to the tungsten-molybdenum and lead-zinc plants of USSR Minsvetmet. Under the threat of disruption, the introduction of the industrial process of flotation of fluorite-containing ores using the reagent "Flotol-7-9" occurs due to the absence of production capacities of this reagent at plants of Minkhimprom.

It would be possible to raise the quality of the barite-containing concentrates and increase the volume of their production if the USSR Minneftekhimprom would ensure the production and deliveries of alkyl sulfates of the fraction C_{16}-C_{18} to plants of USSR Mintsvetmet. The USSR Minneftekhimprom is too late in organizing the production of methylisobutyl carbinol [methylamyl alcohol], which is necessary for the many sub-branches of nonferrous metallurgy. The needs of metallurgists are not provided in such series producible flotation reagents as sodium sulfide, sodium cyanide, butyl xanthate, activated carbon, and thiourea.

There Are Still Many Reserves

The reserves for increasing the complexity of the use of minable and processable raw materials are very great. Thus possibilities of increasing the production of pyrite (main raw material of the sulfuric acid industry) are used not nearly so completely in nonferrous metallurgy, as follows from the program. In the system of USSR Minchermet no attention is paid to the production of concentrates of nonferrous metals and apatite-containing metals. It must be noted that the nonrecovery of copper, lead and so on, in the concentration of iron-containing ores, leads to the fact that nonferrous metals are ultimately turned into steel, making the quality of the steel worse. The USSR Minchermet has available the largest mining-concentration combines, and, therefore, losses from the associated components in the branch are most significant.

The scientific and technical program envisages creating the technology of the comprehensive processing of tailings of magnetic separation of sulfide magnetite ores of the Sokolovka-Sarbay mining-concentration combine located in the Kustanay Oblast. The necessary initial data are obtained, and the TEO [Technical and Economic Substantiation] is fulfilled for the designing of a large industrial plant, which at present is capable of producing 2 million tons of sulfuric acid a year (about 8% of its all-union production at present) and a long list of significant volumes of commercial products of nonferrous metallurgy.

The program envisages the introduction in 1984 of flotation separation to obtain a collective concentrate of nonferrous metals at the concentration plant No. 2 of the Vysokogorsk Ore Administration of the Nizhniy Tagil combine. Besides the possibility of the additional obtaining of concentrates of nonferrous metals, this permits raising considerably the quality of the iron ore-concentrate.

The USSR Minuydobreniy [Ministry of Fertilizers] and USSR Minchermet have not completely solved problems of the comprehensive use of apatite-magnetite ores of the Kovdorskiy and vanadium-holding ores of the Kachkanar deposits.

The completness of the recovery of useful components in the concentration of the mining-mineral raw materials and complexity of their use depend, to a considerable degree, on the equipping of the concentration plants with electronic instruments and apparatuses capable of conducting a continuous check of not only the chemical but mineral composition, instruments for the reliable inspection of the coarseness of the crushing of the mineral raw material, density of different products and level of the foam layer, and also instruments for checking the ion composition of the sludge. It is required to accelerate the development of apparatuses for the preliminary sorting of the raw material which are based on the principle of radiometric, electronic and other effects.

All these instruments and apparatuses are capable of creating and organizing their production of Minpribor [USSR Ministry of Instrument Building, Automation Equipment and Control Systems], which has done very little in this direction. Meanwhile, almost all the industrial processes of concentration are based on different physicochemical properties of not metals, but minerals. There are 55 minerals of copper, 49 minerals of lead, 43 minerals of manganese, and 37 minerals of iron known in nature; but industrial processes of concentration have been constructed for the recovery of 5-10 items and sometimes 1-2 items of these minerals. Therefore, these instruments are no important and necessary.

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OBTAINING METALLIC POWDERS BY ULTRASONIC ATOMIZATION OF MELTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 83 (manuscript received 1 Dec 82) pp 18-24

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[Abstract] While some applications have been made of ultrasonic processes for producing metallic and other powders with melting temperatures up to 1000°C, little is known about the processes governing this atomization. The authors studied design and technological features of ultrasonic atomization and assessed its effectiveness and the qualities of powdered metals obtained. The chamber they designed is diagrammed and described. The process involved forming a vacuum, filling the chamber with inert gas (argon or helium) and heating to 30-50°C above melting point. Factors of choosing the atomizer system and the effects of thickness on powder dispersion and ultrasonic frequency are discussed. The authors assert that the intensity of atomization is the greatest if oscillation frequency of the concentrator focus and that of the melt coincide. Atomization is attributed to the breakdown of capillary ridges by ultrasonic waves. Particles are distinguished by great dispersion and homogeneity, spherical shape, yield and low oxygen content (less than 0.02%). Figures 6; references 12: 5 Russian, 7 Western.
[37-12131]

UDC 621.762

EXPERIMENTAL STUDY OF POWDER PRODUCTION PROCESS USING CENTRIFUGAL ATOMIZATION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 83 (manuscript received 18 Nov 82) pp 13-18

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[Abstract] Temperature and power applications place high demands on powder nickel alloys. The present study reports on a special computer-regulated apparatus for centrifugal atomization that eliminates shortcomings of earlier

methods; a distinguishing feature is the system for mixing a counterflow of argon or argon and helium, which facilitates breaking and cooling of metal particles. The vacuum system provides for up to 1 Pa of vacuum in the oven and atomization chambers, with residual gas pressure of up to 0.02 MPa. Production tests with feed of 0.5 kg/sec, atomizer diameter of 0.09-0.11 m, and 6,000 rpm, and counterflow of argon at 21-42 m/sec., provided granules largely in the range of 200-300 mkm. Results showed that small particles were spherical, but larger ones were irregular. The particles showed almost no gas porosity until dimensions surpassed 630 mkm. The particles were of cellular structure, and their oxygen content was the same as with other production procedures. Figures 6.
[37-12131]

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OBTAINING TITANIUM CARBIDE POWDER FROM TITANIUM SHAVINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 83 (manuscript received 6 Oct 82) pp 24-28

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[Abstract] The reprocessing of titanium waste, which often amounts to 1.5 times as much metal by weight as finished products, is crucial due to the metal's scarcity. The present study reports on a method for obtaining titanium carbide powder from titanium shavings and on optimum carbidization parameters. Original tests did not produce titanium carbide that approached stoichiometric parameters; consequently, further carbidization was conducted in a liquid-solid phase blend. A two-stage carbidization process was finally perfected, with vacuum of 0.013 Pa, and temperature of 1873°K for 1.5 hours, 2273°K for 0.5 hours, subsequent vibration milling for 0.5 hours and finally, 2273°K for 0.5 hours to complete processing. Oxygen content and other parameters exceeded previous domestic Soviet titanium carbide standards. Figures 4; references 9: all Russian.
[37-12131]

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NITRATION OF INTERMETALLIDE $TiAl_3$

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 83 (manuscript received 11 Oct 79) pp 76-80

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[Abstract] Nitration of powder and compact titanium and aluminum separately has received considerable scholarly attention, but Ti-Al systems have not been studied. The present study reports on reactions of $TiAl_3$ with nitrogen and

ammonia in a quartz reactor at 600-1200°C with less than 0.003% oxygen. Below 900°C little nitration took place, but more intensive reaction was observed above that temperature, with the formation of new phases. Stable nitride phases AlN and TiN were joined in special conditions by Ti_2AlN, a less stable system. Since the free energy of their formation was close, no selective nitration was observed; nor were noticeable reactions between phases recorded. The lack of close bonds and marked differences in coefficients of thermal expansion facilitated easy delamination of TiN, AlN and $TiAl_3$ phases. Slower nitration with ammonia than with nitrogen was attributed to hydrogen atoms of the ammonia that hampered the penetration of nitrogen atoms into the metal system. The hydrogen was also much more closely fixed in titanium nitrido-hydrides than in hydrides. The $TiAl_3$ structure consisted of isometric polyhedral crystals of TiN of 100-200 nm interspersed among needle-like AlN crystals 100-700 nm in length. Figures 4; references 9: 6 Russian, 3 Western. [37-12131]

UDC 669.018.25

STRENGTH OF HARD ALLOY ELEMENTS OF HIGH PRESSURE APPARATUS FOR SYNTHESIS OF SUPERHARD MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 83 (manuscript received 12 Aug 82) pp 58-64

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[Abstract] Results are presented from testing of tungsten hard alloys under high hydrostatic pressures. An experimental foundation is developed for the applicability of the corresponding strength criteria to these materials and, based on the results of calculation of the stress state in the most dangerous zones, strength reserve factors are established for an AVD hard alloy matrix for the synthesis of diamond. Tungsten hard alloys containing 6, 15 and 25 mass % cobalt were tested. The commercial designations of these alloys are VK6, VK15 and VK25. Standard circular specimens 4 mm diameter with gage length 12 mm were used for tensile testing. Cylindrical specimens 4 x 12 mm were used for compression testing. Specimens were manufactured by two-stage sintering, yielding satisfactory homogeneity in terms of content and structure of carbon. Deformation curves in compression and in extension with hydrostatic pressure are presented, as well as curves illustrating the variation in ultimate strength in compression and extension as a function of cobalt content for various levels of hydrostatic pressure. Analysis of compression and tensile test data shows that the stress intensity increases with increasing hydrostatic pressure. The fact of increased strength with increasing hydrostatic pressure for hard alloys with low cobalt content in compression testing indicates the effectiveness of the use of low cobalt alloys as materials for the manufacture of heavily loaded high-pressure apparatus. Pressure apparently has a positive effect on the load-bearing capacity of the carbide framework, which is well formed in low-cobalt alloys and receives most of the compressive stress. Analysis of the stress state under the loading and unloading conditions of synthesis indicate that one reason for the failure of hard alloy inserts is redistribution of stresses as pressure is rapidly relieved upon completion of the synthesis process, resulting in significant overloads of the material near the edge. Figures 7; references 10: 9 Russian, 1 Western.
[24-6508]

UDC 669.295'24:620.181

INTERRELATIONSHIP BETWEEN TEMPERATURE INTERVALS OF INVERSE MARTENSITE TRANSFORMATION AND SHAPE RESTORATION IN TITANIUM NICKELIDE-BASED ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 3, Sep 83 (manuscript received 15 Jun 82; in final form 14 Dec 82) pp 521-525

ZHEBYNEVA, N. F., CHERNOV, D. B., KHACHIN, V. N. and GYUNTER, V. E.

[Abstract] A study is presented of the interrelationship between the temperature intervals of the reverse martensite transformation and shape restoration (thermomechanical recovery) in titanium nickelide based alloys containing 51 to 57 wt.% Ni. Alloys were produced by arc melting with an infusible electrode. The primary method used to study the reverse martensite transformation was the method of differential thermal analysis, which can fix the temperature of the beginning and ending of the transformation with accuracy of $\pm$10°C. X-ray structural analysis was also performed in CuK_{α} radiation at room temperature and up to 300°C. Shape restoration begins throughout the concentration interval studied at temperatures higher than the reverse martensite transformation, some 70 to 80°C higher for alloys containing up to 55 wt.% Ni, 20-40°C higher for alloys containing more nickel. To determine the influence of degree of preliminary deformation on the reverse martensite transofmration interval, alloys of various compositions were deformed by up to 4% in compression, while a number of alloys rich in titanium were deformed by up to 20% in compression. Compression of 4% increases the temperature at which reverse transformations begins by 20°C in alloys containing up to 55 wt.% nickel and by about 10°C in more nickel-rich alloys, while the end of the reverse transformation remains constant. Further increases in comparison to 10-12% cause an increase in the temperature at which transformation ends, to a maximum at 16-18% compression, while the beginning temperature first increases slightly, then decreases. The results indicate that the two processes--restructuring of the crystalline lattice and shape restoration--are successive rather than simultaneous at various temperatures. This allows the phenomenon of shape memory to be explained by a model according to which it results from elastic energy accumulated by the lattice in the process of deformation. Shape restoration begins when the elasticity modulus of the high temperature phase reaches values equal to or greater than the elasticity modulus of martensite at the deformation temperature, when the level of elastic stresses generated by the lattice exceeds the elastic stresses arising upon deformation. Figures 3; references 10: 8 Russian, 2 Western.
[23-6508]

UDC 669.292'24'234:669.112.227.346.2:548.76/73.295

MARTENSITE TRANSFORMATION AND SHAPE MEMORY IN $Ti_{0.5}Ni_{0.5-x}Pd_x$ SYSTEM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 3, Sep 83 (manuscript received 13 Sep 82; in final form 30 Dec 82) pp 542-546

SIVOKHA, V. P. SAVVINOV, A. S., VORONIN, V. P. and KHACHIN, V. N., Siberian Physico-Technical Institute imeni V. D. Kuznetsov

[Abstract] Alloys with the composition $Ti_{0.5}Ni_{0.5-x}Pd_x$, where x is 0 to 0.5, are used to study the regularities of formation of the martensite phase and manifestation of the shape memory effect. Particular attention is given to determination of the conditions of maximum manifestation of this effect. The structure was studied on a diffractometer in CuK_α radiation. The structure of the martensite phases was determined by homology. The status of the crystalline lattice in the vicinity of the martensite conversion was judged from the behavior of the shear modulus. The pecularities of accumulation and recovery of deformation with temperature and sequence of martensitic transformation were found to be directly related. The addition of palladium to titanium nickelide replacing some of the nickel causes a change in the sequence of martensitic transformation and a simultaneous change in shape--memory effect parameters. Optimal conditions for manifestation of the effect are obtained when the martensite transformations occur at anomolously low values of lattice elastic constants. Figures 4; references 9: 8 Russian, 1 Western.
[23-6508]

UDC 669.295'28:620.186.1

FLUCTUATIONS IN CHEMICAL COMPOSITION OF TITANIUM ALLOY β-SOLID SOLUTION IN PRESEPARATION STAGE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 3, Sep 83 (manuscript received 9 Feb 81; in final form 16 Nov 82) pp 515-520

ALEKSEYEV, A. A., KOROBOV, O. S., NOTKIN, A. B., SMOLYAKOVA, L. A. and SHESTAKOV, A. D., All-Union Institute of Light Alloys, Moscow

[Abstract] It is thought that before a titanium alloy -solid solution decomposes, areas rich and poor in the alloying elements develop in the volume of the solution. The formation of concentration heterogeneities can be explained by fluctuations in the placement of alloying element atoms at the nodes in the crystalline lattice. This article develops a mechanism for close order delamination of a β-solid solution before the stage of precipitation requiring no diffusion restructuring of the alloying elements. The method is developed by analysis of an unstable solid solution of Mo in β-titanium at a temperature below the $\beta \rightarrow \alpha$ phase transition, assuming that the atoms of Mo are chaotically located in the volume of the alloy. Fluctuations in chemical composition are always present in the β-solid solution of titanium alloys.

Their formation results from random placement of atoms in the crystalline lattice. The volumetric fraction of fluctuations does not change with time. After rapid cooling (quenching) nondiffusion phase transition may occur within the fluctuations, the volumetric fraction of fluctuations being sufficient to have a significant influence on decomposition of the solid solution. Figures 3; references 14: 11 Russian, 3 Western.
[23-6508]

NEW METHOD AND EQUIPMENT FOR HIGH-FREQUENCY WELDING OF PIPE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 2 Oct 83 p 2

[Article by V. Paton, academician, twice Hero of Socialist Labor, Lenin and State Prize laureate: "Fire Weld"]

[Text] Pipes of various grades are one of the most mass-produced types of welded products. Among these are pipes of small and average diameters, which are used, for example, in the construction of branches and separations from pipeline mains, construction around oil and gas fields, and creation of a branching pipeline network. The annual demand for such pipes is measured in millions of kilometers. To satisfy it, the nation began mass production of pipes, based on the high-quality welding approach proposed and developed by Soviet specialists and scientists.

Showing preference for high-frequency currents, the creators of the new method attempted to utilize their capability to flow in the thin surface layer of metal, potential to cause selective intensified heating and flash-off of the necessary sections of the skelp, and the high flow rate of processes and the stability of their characteristics. These qualities, "refracted" in the propoer equipment, made it possible to develop an industrial method which guarantees the production of high-quality pipes at a speed of more than a meter per second.

The first high-frequency welding mills were designed for the preparation of small-diameter pipes. The experience gained from their industrial use indicated that the new method was fully suitable for average-diameter pipes as well. But this required solving a number of new complex problems, caused by the necessity of greatly increasing the capacity of welding mechanisms, having maintained their high reliability and work stability. As a result, new inductors, which provided the requisite heating of large-diameter pipes, were produced. The capacity of current generators increased to 1,500 kw. Reducing the current frequency and utilizing original control systems made it possible to obtain a constantly high quality of weld.

The complexity of the posed task required multilateral comprehensive research and precise work coordination, which was undertaken by scientists and specialists of the All-Union Science and Research Institute of High Frequency Currents imeni V. P. Vologdin, All-Union Science and Research Institute of the Tubing Industry, VNIImetmash [All-Union Science, Research, Planning and Design Institute of Metallurgical Machine Engineering], Electric Welding Institute imeni

Ye. O. Paton, Electric Steel Plant of Heavy Machine Engineering, Vyksunskiy Metallurgical Plant and a number of other enterprises and organizations of the USSR Minchermet [Ministry of Ferrous Metallurgy], Mintyazhmash [Ministry of Heavy and Transportation Machinery Manufacture], Minelektrotekhprom [Ministry of the Power Engineering Industry and Power Machinery Manufacture], and the Academy of Sciences of the Ukrainian SSR. These works were crowned with the creation of the continuous "203-530" mill for high-frequency welding of thin-walled pipes with diameters to 530 mm, which embodies many of the latest scientific and technical achievements.

For example, an original method of welding on voice frequency with induction power supply has no foreign equivalent. The method makes it possible to achieve the productivity and stability of a process and production quality, which greatly exceed the corresponding indicators of foreign mills utilizing contact drive of radio frequency current. The standardized model of welding with composite contactless current supply has made it possible to produce pipes with a wide range of wall thicknesses at speeds up to 80 m/min. The pipe-welding aggregate embodying it is the only one of its kind: it was designed with a set of equipment for all types of thermal processing. This includes equipment for local thermal processing of welds, which assures a pipeline's reliable operation at low temperatures.

Use of the new method of molding pipe skelp has substantially reduced the metal consumptiom of aggregates and made it possible to shorten the mill's length to two-fifths. Mass prpduction of thin-walled, heat-resistant pipes of low metal consumption and with the diameter to wall-thickness ratio reaching 100 has been implemented for the first time on this mill by means of high-frequency welding. Such pipes may be used as gas and drive pipes.

The technical solutions embodied in the new method are protected by 91 invention copyrights and 21 foreign patents. For the first time in the practice of metallurgical machinebuilding, the entire complex of machinery and aggregates was awarded the State Seal of Quality. This distinguished seal also marks the entire assortment of produced pipes.

The new set of high-frequency pipe-welding equipment was put into industrial operation at the Vyksunskiy Metallurgical Plant and in only 10 months reached its design capacity. In 1982 its design capacity was surpassed by 10 percent. This is significant proof of the scientific and technical maturity of the solutions and graphic confirmation of the fruitful union of science and production.

Today hundreds of thousands of tons of oil-and-gas-conducting, thin-walled pipes are produced on the "203-530" mill. Due to their high quality, about 100,000 tons of metal have already been saved. In just 3 years of the mill's operation, more than 540,000 tons of fuel unit have been saved, thanks to the replacement of traditional types of pipes with electric-welding pipes obtained by the new method. The national economy's overall saving from introduction of the mill was over 90 million rubles.

The harmonious efforts of many scientific and production collectives have made it possible to solve successfully, and within time constraints, the most

important task of the national economy. I consider the work "Development and Industrial Introduction of the Method and Machine Aggregate for Producing Domestic Economic Oil-and-Gas-Conducting Pipes with Diameters to 530 mm" worthy of nomination for the USSR State Prize.

12421
CSO: 1842/14

UDC 621.791.72

WELDING WITH ALLOYING AND ULTRASONIC TREATMENT WITH AN ION BEAM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 273, No 1, Nov 83 (manuscript received 21 May 83) pp 104-106

PATON, B. Ye., academician, GABOVICH, M. D., GUREVICH, S. M., deceased, ZAMKOV, V. N., PORITSKIY, V. Ya. and SHEVELEV, A. D., Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, Kiev

[Abstract] This work presents a study of the physical and technologic features of an ion beam which can be used to alloy a welding seam and control its properties. A plasma is diffused from a gas discharge plasma in a vacuum and is transported by a strong magnetic field as a column about 1 mm in diameter. The metal being processed is held at a negative potential of up to 500 V with respect to the plasma. The current density on the axis is up to 100 A/cm^2, specific ion flux power $5 \cdot 10^4$ W/cm^2. The novelty of the method is the increased specific ion flux power and the fact that the flux consists of a controllable mixture of ions of the working gas plus a metal such as titanium. It is found that the ion flux not only introduces atoms of the desired elements into the welded area of the metal, but also subjects the metal to intensive ultrasonic processing. The concentration of microscopic pores after ion beam welding is lower than after ordinary electron beam welding. Ultrasound also causes a decrease in grain size. Future studies must determine the specific capabilities of the ion beam.
[29-6508]

UDC 621.791.03-52:629.12

OVERALL MECHANIZATION OF ASSEMBLY AND WELDING PROCESSES IN THE MANUFACTURE OF SHIPS' STRUCTURES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 83 pp 29-31

SIMONOV, Yu. I., candidate of technical sciences

[Abstract] Welding and assembly operations are closely related, with the maximum speed of welding limited by the speed of assembly. Automatic unilateral welding on machines with flux plus copper inserts with bilateral formation of

seams is most effective for assembly of panels. This technology reduces welding time by a factor of 1.5-2 and eliminates tilting operations. The method can be used for assembly of panels of steel 3 to 32 mm thick. Metal up to 12 mm thick can be welded without edge preparation. For greater thicknesses, V-shaped edge preparation is used. An example of a modern installation is discussed. A section with hydraulic pressing of the edges of sheets together during welding, including an accumulator, sheet placer, feed and orienting roller conveyors, assembly and welding stand with suspended welding head, and discharge roller conveyor, is shown. Photographs of automatic welding equipment used in such installations are presented and technical characteristics are given for the "brig" automatic machine for unilateral welding of sheets up to 20 mm thick. The welding method is distinguished by the simplicity of technology and equipment and relatively low cost.
[22-6508]

UDC 621.791+621.757.06

MECHANIZATION OF ASSEMBLY AND WELDING OPERATIONS IN MANUFACTURE OF SHIP HULL STRUCTURES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 83 pp 27-29

VESELKOV, V. D., candidate of technical sciences, Vyborg Ship Building Plant

[Abstract] Assembly and welding in shipbuilding refers to a separate stage of ship construction called preliminary assembly, which includes the manufacture of units and sections and amounts to as much as 60% of the entire labor consumed in assembly and welding of the ship's hulls. A plan for overall mechanization of the assembly and welding shop of the plant was developed for the manufacture of units and sections of a universal bulk cargo ship with a displacement of 13,000 tons. Equipment was planned, manufactured and put in operation for the mechanized assembly lines of large webs, flat sections, partitions and bulkheads, bottom and side sections and hatch covers, as well as mechanized sections manufacturing T-beams, bottoms and foundations. A pulsating-flow line manufactures bulkheads and superstructure walls of carbon and low-alloy steels. Pieces up to 9000 mm long and 3500 mm wide can be manufactured of 3--12-mm-thick sheet metal. The use of magnetic traverses prevent deformation of sheets and assemblies during transportation. A continuous-flow line with 5 workplaces is used to manufacture large panels. The workplaces are for assembly before welding, automatic welding of joints, marking of assembly locations, placement and welding of primary and supplementary parts. The operation of the line is diagrammed and photographs of its operation are presented. Overall mechanization of the shop has reduced manual operations and improved working conditions while decreasing labor consumption in the manufacture of ship hull sections by 121,000 standard manhours per year. Figures 5; references 8: all Russian.
[22-6508]

UDC 621.791:621.311.25:621.039

INTRODUCTION OF PRODUCTIVE WELDING AND SURFACING TECHNOLOGICAL PROCESSES TO PRODUCTION OF NUCLEAR POWERPLANT EQUIPMENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 83 pp 20-22

UGLOV, Yu. F., engineer, TROFIMOV, I. F., engineer, KHODOSEVICH, A. A., engineer, YUN, M. P., engineer, BAYRAKOVSKIY, G. M., engineer, and YEVTUSHENKO, A. S., engineer, "Izhorskiy zavod" Production Association

[Abstract] Welding and surfacing account for over 30% of the total labor consumed in the manufacture of nuclear powerplant equipment. Significant successes have been achieved in the area of mechanization of welding and surfacing. Several examples are given of successes which have been achieved by the authors' association in automating and mechanizing processes such as surfacing of the internal surfaces of fittings on reactor bodies, automatic welding of joints of complex shape and automatic attachment of fittings to reactors, steam generators and steam separators. Photographs show welding of fittings to a PGV-1000 steam generator by means of an automatic device, automatic electron-arc welding of fittings on a type RBMK steam separator, and a machine for automatic welding of circular seams in a VVER-1000 reactor body. The new technological processes for welding, surfacing and electric slag melting have been tested and put into extensive use in the production of nuclear power equipment at the authors' association. The level of mechanization of welding has increased from 66.5% in 1975 to 72.5% in 1982, of surfacing from 72.0 to 81.0% and of gas cutting from 72.0 to 79.0%. [22-6508]

UDC 621.791.1:534.222.2

CERTAIN FEATURES OF A VACUUM MAGNETIC-IMPULSE WELDING PROCESS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 18 Dec 81) pp 104-108

STRIZHAKOV, Ye. L., SHORSHOROV, M. Kh., ASOTOV, A. I. and LOKTIONOV, A. M., Rostov-on-the-Don, Moscow

[Abstract] High-energy welding in the solid phase provides effective bonds while preserving original structure. For thin-walled facings, vacuum magnetic-impulse welding has the advantage of eliminating initial clearance or permitting normal contact during welding. This study presents computer calculations of such processes, thus reducing the need for lengthy practical experiments. The key to accuracy is based on choosing the right mathematical model to take account of the pulsed nature of the electromagnetic field, its penetration into all conductors in the system, motion of the cast element and effect of the discharge contour of the magnetic-impulse apparatus, etc. Features of the process are increased contact rate along with increased clearance, and higher

magnetic field power in the clearance between coatings and base at contact time. The discontinuity of the axial component of magnetic field tension is ordinarily about 1%, increasing to 15% in small zones near the coating edge. Bonding occurred from the beginning of physical contact until the magnetic pressure began to create a stretching in the bonding zone. Figures 3; references 6: all Russian (one translation).
[20-12131]

MISCELLANEOUS

SUPERFINE WIRE MADE FROM NEW ALLOY

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 Dec 83 p 4

[Article by I. Konstantinova: "A Kilometer in Length, A Gram in Weight"]

[Text] It is improbably but true: a 1,000-meter length of this ultrafine wire weighs altogether only 1 gram. A piece of it lay almost like an invisible cobweb on a page of my note pad and kept quivering as though about to fly off at one slight puff of my breath. And alongside was a tiny spool on which was wound a full kilometer of a wire that is 5 times finer than human hair.

The extraordinary wire owes its existence to a new alloy which is based on nickel in combination with three other metals: chromium, vanadium and gallium, whence the new alloy's name--chrovangal. It was created in the Scientific Production Association of the All-Union Scientific Research Institute of Metrology imeni D. I. Mendeleyev under the supervision of V. Kukhar', chief of the physico-technical materials research sector and candidate of technical sciences.

"All the measuring devices used in science, industry, medicine, and all branches of the economy are calibrated by the instruments of metrologists," reports Vasily Valentinovich. "The more sensitive these instruments are, the greater is the precision of measurement in practice. In order to achieve high sensitivity, special materials are needed, such as alloys with predetermined properties."

One of the problems that confronted the scientist was that of producing an alloy for a standard of electrical resistance. Wire made from it had to be as thin as possible and able to maintain a maximum resistance over a wide range of temperatures. One might wonder what's so special about that. But even to begin solving this problem, the laws of nature that determine the properties of this or that metal "cocktail" had to be discovered. It was therefore necessary to examine the various combinations of virtually all the elements in Mendeleyev's periodic table.

Hundreds of laboratory alloys were prepared by V. Kukhar' with master smelter V. Marusin. Not only copper, nickel, aluminum, titanium, chromium, vanadium, manganese--all readily available--were used in these alloys, but also palladium, silver and even gold. The priority of the inventors of chrovangal is protected

by patents in England, East Germany, Hungary, Italy, the United States, Australia, France, Japan, West Germany, Switzerland, Sweden, and Holland. Of course it would be! In wire made of this alloy, the electrical resistance changes no more than 0.001 percent over a temperature range of -60° to 200°C. This property has turned out to be literally invaluable, not only for standards but in the manufacturing of such items as resistors as well.

From 15 to 50 percent of the total number of components in instruments and radio electronic systems consist of resistors. It is no coincidence that the worldwide volume of resistor production has doubled over the past decade and is now approaching 30 billion units annually. They are necessary in automation and remote control systems, and in instruments and electrical equipment. The originators of all this equipment immediately became interested in this amazing wire made of chrovangal when they first heard about it. A problem thus arose that far exceeded the bounds of metrollgy: that of organizing the commercial production of superfine wire.

People working in production came to the aid of the scientist. Specialists in the Leningrad steel-rolling plant under the supervision of the chief of the central plant laboratory, A. Kalugin, candidate of technical sciences, designed the technology of producing the alloy and its billets. These billets were then sent to the Beloretskiy Metallurgical Combine in Bashkir, where V. Dubov, chief of the research laboratory, was actively involved in devising a production process that yielded superfine wire using rolling and drawing techniques.

The partnership with production specialists turned out to be beneficial for V. Kukhar' too. Following the invention of chrovangal, he collaborated with A. Kalugin and V. Dubov to create yet another alloy. This alloy is even more suitable than chrovangal for some types of resistors. This even though it is markedly cheaper, since its expensive components were replaced with more available ones. And even further advances are in store.

9992
CSO: 1842/39

UDC 542.65:546.47.23

LASER SCREENS OF ZnSe PRODUCED BY BRIDGEMAN METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 19, No 11, Nov 83 (manuscript received 16 Apr 81) pp 1807-1810

KULAKOV, M. P., MEYEROVICH, G. A., ULASYUK, V. N., FADEYEV, A. V. and
KHASANOV, I. Sh., Institute of Solid State Physics, USSR Academy of Sciences

[Abstract] Zinc selenide, a rectizonal semiconductor of the $A^{II}B^{VI}$ group with a 2.7 electron volt "forbidden zone" width at 300°K, is studied as a material for laser screens. Cathode luminescence of the initial samples was studied to establish the connnection between the resulting spectra and laser screen generation parameters. Results indicated that impurities were eliminated by the crystallization process, which yielded a crystal that diverged from stoichiometry in the direction of excess selenium. Spectral data gathered during production and during laser generation confirm that ZnSe produced by this method can be used to make laser screens with threshold current density of up to 40 A/cm^2 and efficiency of up to 3% at ca. 100 A/cm^2. Cathode luminescence was an effective criterion for material quality control. Reduced threshold current could be obtained by reducing the concentration of zinc vacancies in the compound's stoichiometry. Figures 4; references 10:
5 Russian, 5 Western.
[40-12131]

UDC 666.3.8:661.847:661.691

STRUCTURAL FEATURES OF POLYCRYSTALLINE ZnSe AND SOLID SOLUTIONS $ZnSa_{1-x}S_x$

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 19, No 11, Nov 83 (manuscript received 16 Apr 81) pp 1802-1806

KOMOLOVA, L. F., GROSHEVA, L. A., MUKHINA, L. L., SAKHAROV, V. V., PROYANENKOV, V. V., RAZUMOVSKAYA, I. V. and SHEVTSOVA, N. F., Moscow State Pedagogical Institute imeni V. I. Lenin

[Abstract] Polycrystalline zinc selenide, used in optical electronics, and the solid solution $ZnSe_{1-x}S_x$ with its greater thermal resistance are compared during crystal formation and the effects of structural features on optical

and mechanical characteristics are summarized. Cathode luminescence, X-ray phase analysis and spectrophotometry showed forms and spectral features at various temperatures of recrystallization. Results indicated that the accumulation of defects at granular boundaries caused poor light transmission and high microhardness values. Granular size was not a factor in microhardness, and was similar for the solid solution as for the polycrystal ZnSe. Figures 4; references 12: 9 Russian, 3 Western.
[40-12131]

UDC 539.3-534.2.231

INFLUENCE OF ANISOTROPY AND VISCOSITY ON PROPAGATION ON WAVES IN MULTILAYER CYLINDERS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 83 (manuscript received 27 Jan 83) pp 40-44

GALIYEV, Sh. U., ROMASHCHENKO, V. A., ALPAIDZE, Z. G., Institute of Strength Problems, Ukrainian Academy of Sciences, Moscow

[Abstract] A study is presented of the influence of viscosity and anisotropy of the material of several layers of a cylinder of finite length on the propagation of waves caused by the application of an axisymmetrical pressure pulse. The equations of motion of the solid deformed body are integrated by the method of finite differences. An analysis is presented of the influence of the direction of the fibers of an orthotropic layer on the distribution of stresses, as well as the viscosity properties of the layers on wave attenuation. It is shown that the use of outer layers of viscous materials can significantly decrease the stress level in inner layers. This effect increases with a decrease in the duration of loading. For short load pulses which cannot influence the dynamics of the entire structure the direction of fibers along the line of action of the load increases strength. Figures 6; references 9: all Russian.
[24-6508]

UDC 539.4

ANALYSIS OF UNSTEADY PROCESSES CAUSED BY NONAXISYMMETRICAL LOADING OF FINITE MULTILAYER CYLINDERS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 83 (manuscript received 17 May 82) pp 3-7

ALPAIDZE, Z. G., BABICH, Yu. N., GALIYEV, Sh. U., Institute of Strength Problems, Ukrainian Academy of Sciences; Moscow Heat Engineering Institute

[Abstract] A brief description is presented of an algorithm for calculation of the three-dimensional stress state of multilayer finite cylinders subjected

to nonaxisymmetrical loading. The layers in the cylinders are made of different materials. Rigid bonding without interference is achieved between the layers. A pressure pulse 10^{-5}-10^{-9} s in length acts on the outer surface. The pressure pulse is distributed around the circumferential direction according to a cosine rule. It is found that the number and placement of layers of dissimilar materials have a significant influence on dynamic strength. In multilayer structures subjected to pulse loading, the outer layer should not be made of a material with significantly inferior mechanical characteristics in comparison to the next inward layer, since this causes a sharp increase in stresses in the structure. The method developed for calculation of the stress-strain state in such structures can be used in planning and dynamic design of variable rigidity structures. In particular, it can be used as the basis for solution of the problem of selecting the placement of layers providing the least stress in multilayer structures. Figures 6; references 6: all Russian.
[24-6508]

UDC 669.018:539.26

SPECIFICS OF PROCESSES OF DEFORMATION AND MICROFRACTURE OF AMORPHOUS IRON-BASED ALLOYS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 272, No 5, Oct 83 (manuscript received 26 Apr 83) pp 1114-1118

UTEVSKAYA, O. L., GLEZER, A. M., KANTOR, M. M., KOLOTINSKIY, V. N., and MOLOTILOV, B. V., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin; Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] Amorphous Fe-B alloys with the addition of small quantities of elements decreasing surface energy (Sb, Ce) were produced in the form of strips, hardened from a melt on a rapidly rotating disk. The strips were 20 to 50 μm thick, 1.5 to 20 mm wide. The specimens were loaded in a high voltage JEM-1000 electron microscope column with a standard installation for tensile testing at room temperature, allowing a smooth increase in load or holding at constant load. The stages of crack development are described. Birth and development of the cracks in the alloys are illustrated on electron micrographs. It was established in particular that alloying with small quantities of surface active elements qualitatively changes the mechanism of crack formation and development. In Fe-B alloys without Sb or Ce, crack development includes stages of increasing the width of a crack at constant length, formation of a small oval "emissary" crack near the tip of the main crack within the zone of plastic deformation, and growth of the emmissary crack in length and width, after which the emmissary merges with the main crack. In alloys containing Sb or Ce there are two major stages: slow growth of the crack in length and width under constant load, with the shear zone remaining unchanged; as the load increases the crack suddenly increases in length and width and a new shear zone forms before its tip; identical increases in load cause an order of magnitude greater increase in crack length than in the alloy without the surface-active additive.
[21-6508]

UDC 532.13:669.01

SOME SPECIFICS OF CRYSTALLIZATION OF REINFORCED QUASIMONOLITHIC INGOTS AND CASTINGS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 272, No 5, Oct 83
(manuscript received 12 Aug 82) pp 1108-1110

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[Abstract] Reinforced quasimonolithic metal materials (RQM) act as monolithic materials under static loading and as multilayer materials under dynamic loading. The specific properties of RQM are determined by their production technology: casting in a mold with reinforcing inserts. The temperature at the moment of pouring, crystallization interval, ratio of mass of melt to insert, geometry and other factors influence the interaction of the melt and insert. The first stage of crystallization, regardless of technology, is the formation of a crystalline crust on the surface of the reinforcing inserts, after which they are heated. Subsequent interaction of inserts and crystallizing melt may vary. Drawings illustrate the crystallization of RQM metal with and without partial melting of the inserts. The use of reinforcing inserts can produce high-quality metal, comparable in properties to metal obtained by remelting processes but at significantly lower cost. Figures 2; references 5: all Russian.
[21-6508]

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TITANOCERAMIC WALL OF A THERMONUCLEAR REACTOR

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[Abstract] Requirements of the inner wall of thermonuclear reactors include low charge number, slight permeability and gas transfer, resistance to blistering and suitable recondensing of particles, along with good thermal conductivity. Alumosilicate ceramics such as mullite, zirconium and other minerals have been imperfect. Plasma-arc coating of titanium on beryllium oxide, tested here, showed promise. With low gas transfer combined with heat thermal conductivity. Radiation resistance was nearly as high as for beryllium stainless steel. Gas emissions became significant at 250-300°C, reaching a maximum at 600-650°C. Every square meter of the plasma-coated layer fixed no more than 4 grams of hydrogen. Gas emission was far less than for common ceramics reinforced with metal fibers. Figures 2; references 4: 3 Russian, 1 Western.
[20-12131]

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EFFECT OF ALLOYING ON HEAT RESISTANCE OF V ANADIUM AS A MATERIAL FOR THERMONUCLEAR REACTORS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 24 Feb 83) pp 22-28

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[Abstract] The use of the otherwise promising vanadium for the inner walls of thermonuclear reactors has the shortcoming of ready solubility in the oxygen contained in the helium coolant, leading to brittleness. Requirements for reactor walls show the need for alloying additives that will reduce vanadium's solubility in oxygen. Mathematical calculations are presented for evaluating thermodynamic effects of alloying on oxygen solubility. While niobium, chromium, molybdenum, tungsten, manganese and iron had no appreciable effect on that solubility, they did retard the kinetics of oxygen penetration into the alloy. Possible emergency situations in reactors are also considered. In order of decreasing solubility, TiO_2, TiO, Al_2O_3, ZrO_2, Sc_2O_3 and Y_2O_3 were found to be useful, and also provided reduced brittleness. Titanium was most effective in reducing the depth of oxygen penetration, followed by aluminum and chromium. Figures 2; references 22: 10 Russian, 12 Western. [20-12131]

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